QUANTITATIVE MEASURES OF CHAOTIC PARTICLE DYNAMICS IN THE GEOMAGNETIC TAIL

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We examine the chaotic nature of the particle dynamics focusing on the 1) fractal dimension of the basin boundary separating forward and back scattered particles, 2) the time asymptotic value of the Lyapunov exponent for a distribution of orbits with the same initial energy, 3) the average Lyapunov exponent for the same distribution of orbits, 4) the average "kick" that a particle receives during its interaction with the current sheet, 5) the fraction of orbits that enter the chaotic region of phase space and 6) the trapping time of the orbits while in the midplane. For each of the parameters listed above, we vary both the particle energy (H) and the ratio of the magnetic field strength at the midplane to the asymptotic magnetic field strength (b_z). It is shown that all of the parameters have peaks (or valleys) at particular resonance energies where the underlying phase space has a high degree of symmetry. When b_z approaches zero (a condition where all orbits are integrable), we find that the dimension of the basin boundary is an integer and the Lyapunov exponent is zero. Since the discovery that charged particle dynamics in the magnetotail current sheet is chaotic, it has been conjectured that when the asymptotic ion gyroradius is equal to the minimum radius of the current sheet, the chaos would be maximized. We find that the only parameter that is in fact maximized is the number of particles that enter into the chaotic region of phase space.